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A RE-INVESTIGATION OF THE FIND-SITE OF THE HUCKITTA METEORITE FROM CENTRAL AUSTRALIA

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ABSTRACT

The Huckitta meteorite from Central Australia is the largest known pallasite. Excavation of the find in 1937 showed that the 1415 kg unweathered main mass rested on a much larger sub-surface body of weathered remains known as "iron shale" in which the metal phase has completely oxidised but the pallasite structure is preserved. Madigan (1939) reported that all the meteoritic material had been removed. Further excavation in 1986 showed that the extent of the iron shale was greater than previously thought and approximately 1000 kg were collected and lodged with the Northern Territory Museum. The "crater" described by Madigan (1939) was not of impact origin but represented an aeolian feature known as a wrap-around dune. A terrestrial age greater than 18 000 years in suggested for the Huckitta meteorite.

KEYWORDS: Meteorite, Huckitta pallasite, field observations, Central Australia.

INTRODUCTION

The Huckitta meteorite is a large pallasite (stony-iron) which was found about 220 km north east of Alice Springs, Northern Territory of Australia at latitude 22°22'S, longitude 135°46'E. The main mass was reported to Dr C.T. Madigan, the noted geologist and explorer, during his 1937 expedition to the Tarlton Range in the northern Simpson Desert. Madigan visited the site on what was then Huckitta pastoral station and succeeded in acquiring the meteorite for the South Australian Museum. Brief mention of the find was made in Madigan (1937) and full details of the discovery and recovery, as well as chemical and petrological analyses, appeared in Madigan (1939). A small pallasite found in 1924 near Alice Springs (Spencer 1932) is considered to be a transported piece of the Huckitta meteorite (Madigan 1939; Corbett 1968). Additional chemical analyses of the meteorite were presented in Buseck and Goldstein (1969) and Scott (1977).

In 1985 the Northern Territory Museum acquired a 10 kg piece of the weathered remains (iron shale) of the meteorite reported to have been recovered from the site of the main mass earlier in the year. "Iron shale" usually refers to the laminated iron oxides produced by the weathering of an iron meteorite (Bates and Jackson 1980). Here we follow Madigan's (1939) precedent and use the term to describe all meteoritic material in which the metallic phase has weathered to iron and (minor) nickel oxides. Although some clearly laminated material was present (Fig. 1) the bulk of it appeared massive. When sectioned, many apparently massive hand specimens show a variously developed planar fabric, though the pallasite structure is perfectly preserved (Fig. 2). The recent recovery of a piece of iron shale aroused our interest as Madigan (1939:356) indicated all the meteorite material had been excavated and removed. A reconnaissance of the site in April 1986 showed evidence of recent excavation by fossickers but significant quantities of iron shale were still *in situ*. In July 1986 about 1000 kg were excavated and lodged with the Northern Territory Museum in Darwin (N.T. Museum registration numbers 861-1 to 861-25 inclusive). An additional 25 kg mass is held by the Northern Territory Geological Survey.

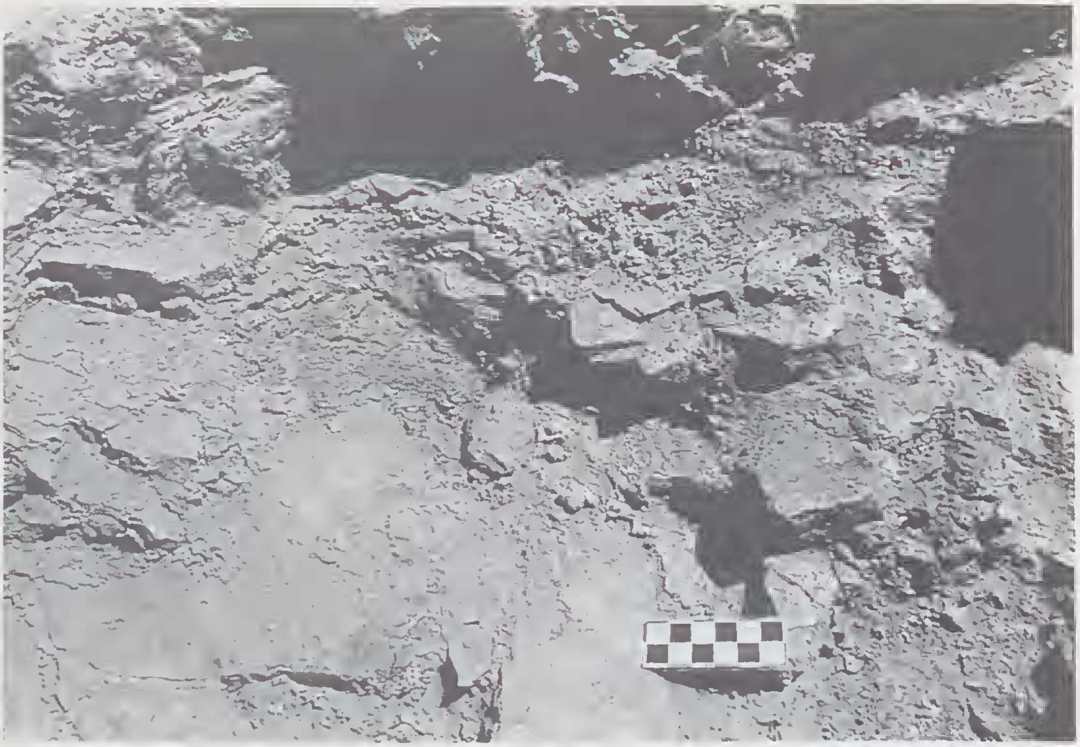

Fig. 1. Huckitta meteorite "iron shale" *in situ* showing the localised well-developed planar fabric. Most of the iron shale appeared massive. Each division of the scale bar is 1 cm.

An account of our observations and interpretations may be of some interest as a sequel to Madigan's (1939) paper.

THE MASS AND ORIENTATION OF THE METEORITE

The following account of the natural position of the Huckitta meteorite before recovery in 1937 is taken from Madigan (1939).

The unweathered main mass was found in a shallow depression on a devegetated plain of sandy gravel. Denudation of the vegetation in the vicinity was apparently the result of the area being used for cattle mustering. The depression and the low rim which bounded it resembled a very shallow crater. The position and orientation of the main mass within the depression, and the presence of a distinct break in the rim on the western side (Fig. 3), gave Madigan the impression the meteorite had arrived from 16° south of due west, travelling in an easterly direction. The unweathered portion of the meteorite rested on a much larger sub-surface mass of iron shale. From the geometry of the material *in situ* it was clear that the unweathered mass represented the core, or kernel, of the meteorite. Weathered material above the ground surface was dispersed by the agents of erosion but the subsurface iron shale remained unmoved. The original mass of the Huckitta meteorite before weathering and dispersal of the products was estimated at over ten imperial tons (approximately equal to 10 t). The unweathered main mass weighed 1415 kg and a total of 927 kg of iron shale were recovered. Madigan was not present during the final stages of the 1937 recovery operation but noted the inconsistency in the size of the excavation and the quantity of iron shale received at the South Australian Museum. He attributed the discrepancy to large amounts of iron shale breaking finely and being discarded.

In 1986 the meteorite site was marked by a hole in the ground, flanked by two old, low spoil heaps (Fig. 4). These were the only notable features on the plain which had in the intervening years been sparsely revegetated with stunted thorn bushes. The hole had recently been cleared and deepened at the western end by fossickers and freshly exposed iron shale was visible on the southwestern face. No trace of the depression rim described by Madigan remained.

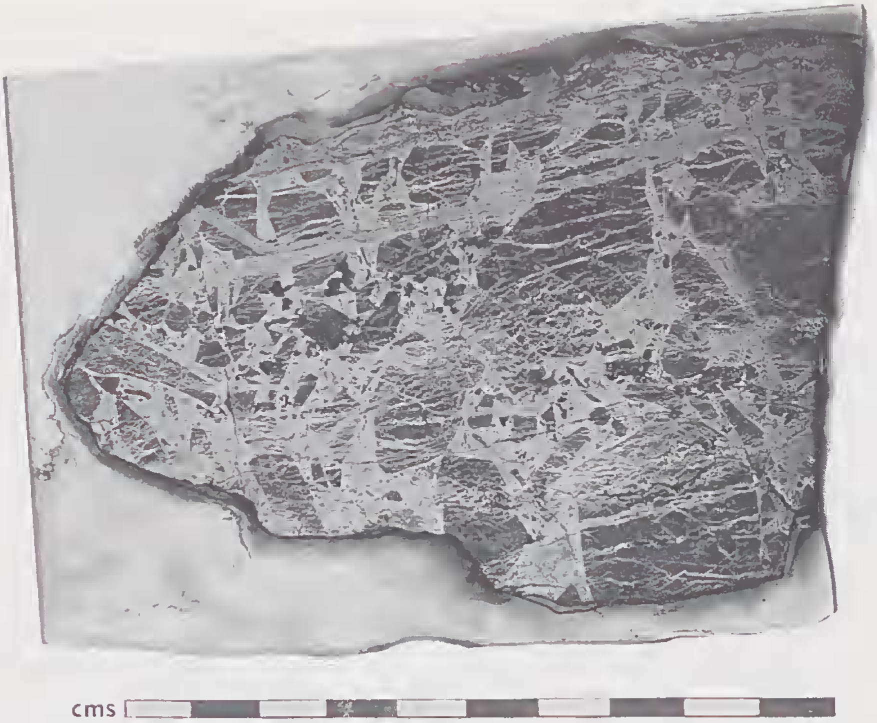

Fig. 2. Polished section of an apparently massive hand-specimen of iron shale (NTM 821-26). The pallasite structure is preserved though iron oxides have invaded fractures in the olivine crystals. The dominant crystal-fracture direction (left to right in the photograph) produces a planar fabric. Such specimens are not fissile along these planes.

The hole was initially cleared to reveal the extent of the iron shale remaining. In plan view the outline of the shallowest material showed a close correspondence to that recorded by Madigan (1939). Iron shale up to 10 cm maximum thickness extended across the bottom of the excavation and up the northern and southwestern faces, while a more substantial mass lay on the western side (Fig. 3). Further excavation showed that this mass penetrated both deeper and further westward than previously thought. Nevertheless the estimate of over ten tonnes for the original mass appears to be of the right order.

The thin (10 cm maximum thickness) lining of iron shale was first removed, though much of it was too friable to collect successfully. An attempt was made to dislodge the large block of iron shale by pulling it towards the centre of the excavation with a vehicle winch. The iron shale was not cohesive enough and broke up. The three largest pieces weighed 62, 85 and 100 kg respectively, with nine other specimens weighing between 10 and 36 kg. The remainder of the iron shale recovered consisted of smaller pieces. Total yield lodged with the Northern Territory Museum is estimated at about 1000 kg of iron shale. Some material found *in situ* was rejected on site because it was considered too finely fragmented to warrant collection, or too friable to withstand transportation over rough terrain.

TERRESTRIAL HISTORY

The crater described by Madigan is clearly too small to have been produced by the impact of such a large meteorite. Its geometry showed that it was related to the unweathered core of the meteorite rather than the original mass (Fig. 3). The "crater" was probably an aeolian structure similar to a wrap-around dune as described by Mabbutt (1977: 246). A wrap-around dune is a windward accumulation of sand which arcs around a narrow obstacle, with the convex side facing upwind. The upwind dune face slopes gently in contrast to the steeper downwind face and the leeward side of the obstacle is relatively clear of windborne

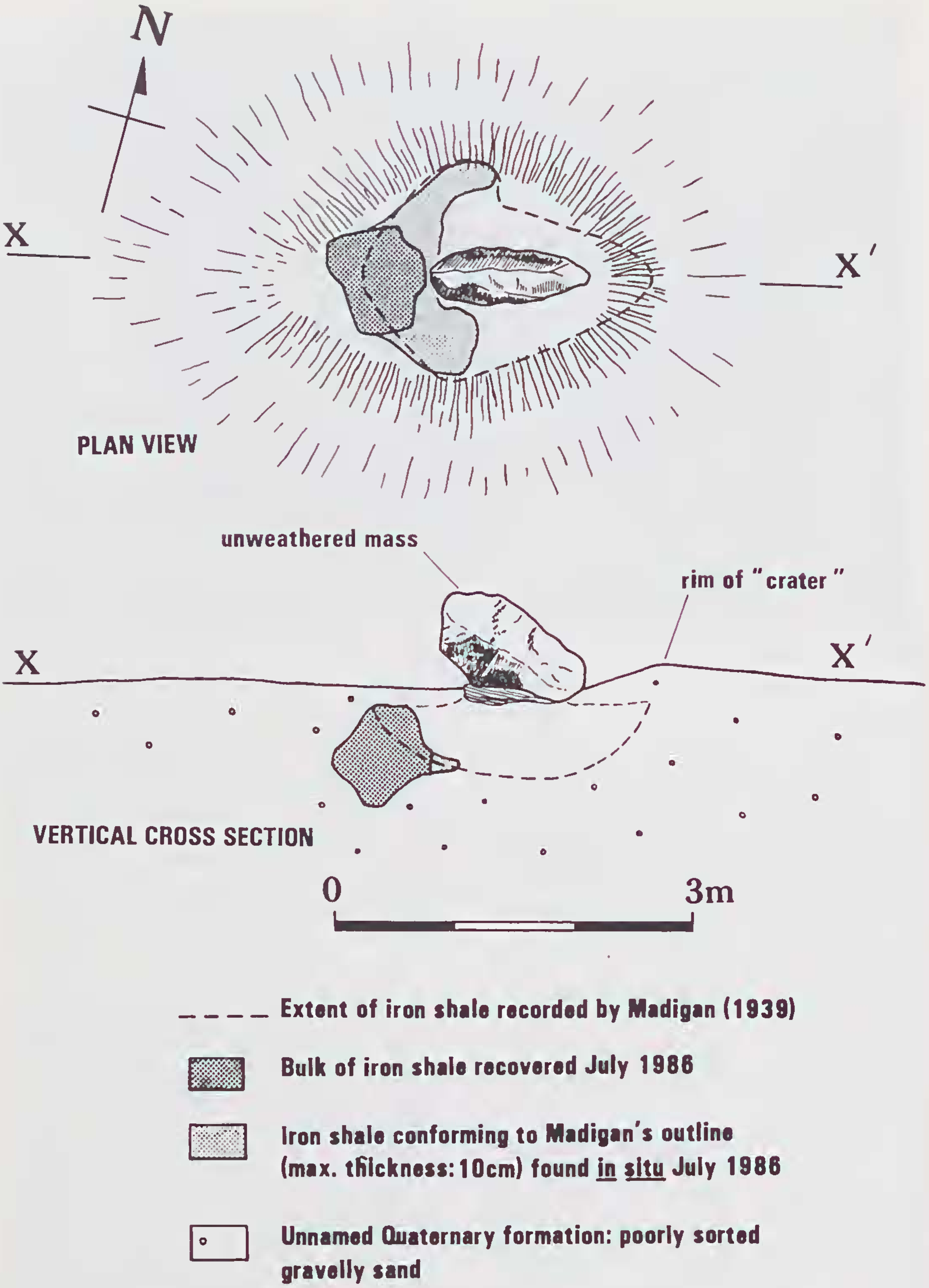
N
X
X′
PLAN VIEW
unweathered mass
rim of "crater"
X
X′
VERTICAL CROSS SECTION
0
3m
– – – – Extent of iron shale recorded by Madigan (1939)
▩ Bulk of iron shale recovered July 1986
▨ Iron shale conforming to Madigan's outline (max. thickness: 10cm) found in situ July 1986
☐ Unnamed Quaternary formation: poorly sorted gravelly sand

Fig. 3. Plan and cross section of the Huckitta meteorite based on the illustration in Madigan (1939). Madigan's vertical cross section was drawn through, or parallel to, the long axis of the unweathered mass and not on an E/W axis as he indicated. He also showed a distinct rim on the western edge of the depression in which the meteorite stood (not shown here). In plan view however, he showed a distinct break or reduction in elevation of the rim on that side; a feature which he also stressed in the text.

sand. These features are consistent with the structure described and illustrated by Madigan (1939). The orientation indicates the dune was formed under the influence of a WNW wind sweeping across the denuded cattle mustering area. It gives no indication of the direction of flight of the meteorite before impact.

The Huckitta pallasite was found in the piedmont of the Dulcie Range on an alluvial interstream area of the Turkey Creek drainage system. The elevated part of the range lies to the south but basement of predominently quartz arenite of the Cambro-Ordovician Tomahawk Beds crops out extensively in the vicinity of the find. Areas between outcrops may be relatively deeply alluviated by Quaternary reworkings of the older basement. Even in the arid landscape any structure on a piedmont, such as an impact crater, is particularly vulnerable to rapid erosion or burial. The Dulcie Range is capped by the remnant of a probably once extensive silcrete horizon which may be as old as Eocene or as young as Pliocene (Freeman 1986). If the younger age for the silcrete is correct, the average rate of erosion in the vicinity of the meteorite find has been relatively rapid since Pliocene times. No visible trace of an impact structure in the vicinity of the find remains.

The time of fall of the Huckitta meteorite cannot be determined by stratigraphic methods. Cosmic ray-produced radionuclides such as ^{10}Be, ^{14}C, ^{26}Al and ^{81}Kr have been measured and used to determine terrestrial ages (e.g. Boeckle 1972; Schultz and Freundel 1984; Nishiizumi *et al.* 1986). An analysis of cosmogenic radionuclides in the Huckitta meteorite will be undertaken and the results presented elsewhere (J.R. Arnold, pers. comm.). An attempt will also be made to determine a minimum age of weathering using palaeomagnetic methods on oriented samples collected druing the April 1986 visit (M.Idnurm, pers. comm.).

No data have been published on weathering rates of pallasites. In the Huckitta iron shale the olivine crystals do not appear to be significantly weathered, though crystal fractures have been invaded by iron oxides. Madigan (1939) found no evidence of alteration compared to olivine from the unweathered mass; A. Bevan (pers. comm.) noted incipient serpentinization. In contrast, the metallic phase has undergone nearly com-

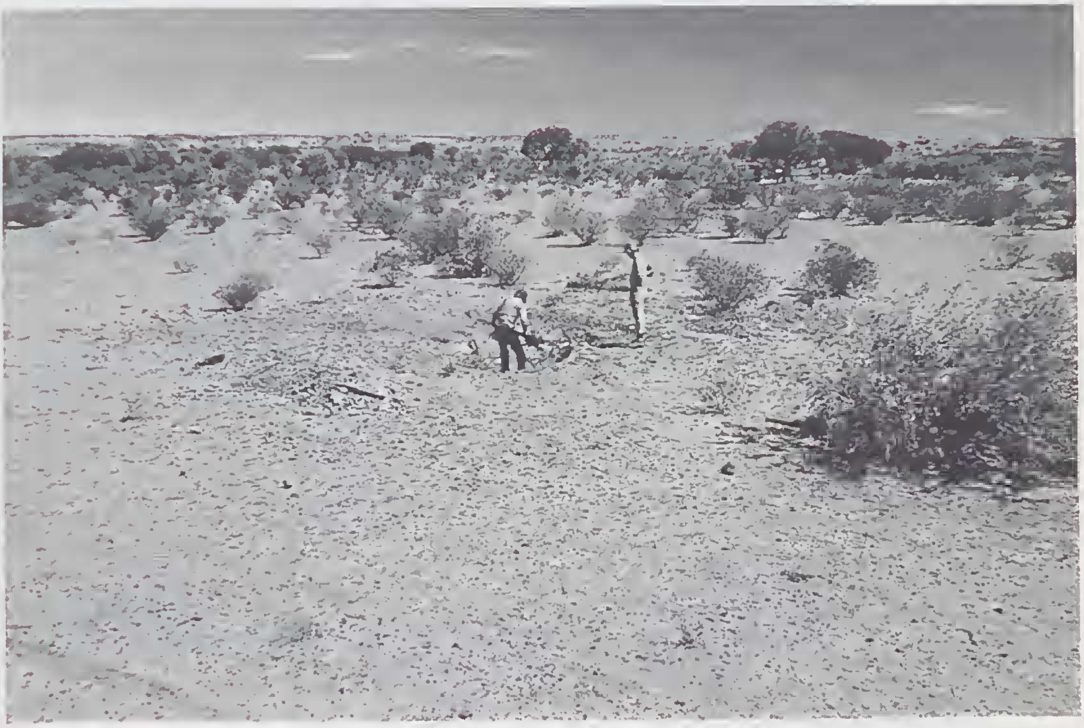

Fig. 4. Panoramic view to the west taken in 1986 showing the site of the Huckitta meteorite find in the middle distance.

plete oxidization. Terrestrial alteration has not destroyed the pallasite structure.

Quaternary palaeoclimatalogical inferences for Australia based on palynological, faunal and geomorphic evidence suggest that the climate fluctuated during the last 120 000 years (Hope 1984), but reached an extreme at the peak of the last glacial period, 18 000 years B.P. At that time the climate was cool and dry. The present hot, dry climate of central Australia was established by 10 000 years B.P.

The approximately 75 cm thickness of iron shale found beneath the unweathered mass of the Huckitta meteorite, the preservation of the pallasite structure in the iron shale and the inferred arid climate in central Australia for at least the last 18 000 years suggest a long period of slow weathering. A terrestrial age greater than 18 000 years is indicated.

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